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AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Applicant(s):

BHP STEEL LIMITED

A.C.N. 000 011 058

Invention Title:

FORMING APPARATUS FOR PRECAMBERED METAL SECTIONS

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The invention is described in the following statement:

FORMING APPARATUS FOR PRECAMBERED METAL SECTIONS

Technical Field

The present invention relates to an apparatus for and method of, forming a metal section from sheet metal strip. The invention has been developed especially for roll forming metal profiles such as metal decking and the invention is herein described in that context. The invention however has broader application and is not limited to that particular use.

Background of the Invention

Composite structures formed from metal decking on which a concrete slab is cast are commonly used in building. Typically, the decking is installed on site so as to span supporting elements, such as columns or walls. The decking includes a pan section and upstanding edge regions which are in abutting relationship so as to form a continuous surface. Concrete is cast over the surface so that the upstanding edges are embedded in the slab. The metal decking therefore acts both as formwork for casting of the slab, and also provides tensile strength to the structure on curing of the slab.

In the applicants' earlier International applications, PCT/AU01/01446, and PCT/AU01/01447, an improved metal decking is disclosed which incorporates a precamber in the longitudinal direction of the decking. The purpose of the precamber is to compensate for deflection of the decking on casting of the slab thereby enabling the decking to span greater lengths without exhibiting excessive deflection of the composite structure. The decking in these earlier applications also discloses an improved edge interlock arrangement which further improves the strength of the composite structure.

Whilst metal decking according to the above form has improved performance, difficulties have been encountered in incorporating the precamber into the metal section.

Summary of the invention

An aim of the present invention is to provide an arrangement where a precamber can be introduced into a metal section.

Accordingly, in a first aspect invention relates to a method of roll forming a metal section from sheet metal strip comprising of the steps of;

- differentially stretching the metal strip in its longitudinal direction so that at least one portion of the metal strip is more elongated than a laterally adjacent portion of the strip;
- roll forming the differentially stretched metal strip to form a profiled section; and
- bending the profiled section so as to introduce a longitudinal precamber in the profiled section.

An advantage of the present invention is that the profile and precamber can be introduced into the section in a single pass. Furthermore, the method can be easily introduced into an existing roll forming line merely by including additional processing stations.

The applicants have found that by preconditioning the metal strip through differential prestretching, the amount that the metal section can be bent without buckling of the section, or introducing significant areas of weakness in the metal section, can be significantly increased.

In a preferred form, the elongated portion(s) of the strip extend continuously in a longitudinal direction of

the strip.

In a preferred form, the elongated portion(s) are aligned in areas of the metal strip which require stretching to induce curvature in the final rollformed product. The differential stretching is designed at least in part to compensate for the tendency of some parts of the metal section to shorten longitudinally as a result of lateral bending during roll forming of the metal strip. In formation of a metal sections having shaped flanges that project in one direction form a web, the metal section tends to bow longitudinally inwardly, with its centre of curvature on the opposite side of the web to which the flanges project. This occurs because rollforming to shape the flanges results in longitudinal stretching of the flanges

In an embodiment of the invention, the metal strip is of a generally C profile having upturned shaped flanges which extend from one face of the strip. Further, the differential stretching is designed to compensate at least in part for the tendency of the worked sections of the metal strip to shorten longitudinally so as to cause the metal strip to bow. Furthermore, the bending of the profiled section is about the face opposite to that in which the upturned edges of the section extend.

In one embodiment, the metal strip is roll formed so as to be differentially stretched.

In a preferred form, the profiled section is caused to bend about a fulcrum to introduce the longitudinal precamber. In one embodiment, the profiled section is restrained upstream from the fulcrum and is caused to be deflected from the roll forming line downstream of the fulcrum. In this arrangement, a three point bending process is formed to introduce the longitudinal precamber.

In one form, the apparatus to shear the profiled section into discrete lengths is used as part of the three point bending process. Preferably, the shearing apparatus is adjustable so that it can be set to cause the profiled section to be deflected from the general line of the roll former. In that arrangement, the metal section at the shearing apparatus is inclined to the line of the roll forming. In a preferred form, the cutting surface of the shearing apparatus can be similarly inclined so that the shearing action remains perpendicular to the metal section.

In a further aspect, the invention relates to an apparatus for forming a metal section from sheet metal strip, the apparatus comprises:

stretching apparatus which is operative to differentially stretch the metal strip in its longitudinal direction so that at least one portion of the metal strip is more elongated than a laterally adjacent portion of the strip;

rollforming apparatus operative to roll form the differentially stretched to form a profiled section; and

bending apparatus operative to bend the profiled section so as to introduce a longitudinal precamber in the profiled section.

In a further aspect, the present invention relates to a shear assembly for use cutting a profiled metal section, the shearing assembly comprising an assembly frame, a shearing block attached to the frame and operative to receive the profiled metal section, and a cutting element which is moveable relative to the shearing block; wherein the shearing assembly is height adjustable so that the relative height of the shearing block can be adjusted and the angle of the cutting element relative to the frame can be adjusted.

It is convenient to herein after describe an embodiment of the present invention with reference to the accompanying drawings;

In the drawings;

Figure 1 is a schematic perspective view of metal decking for use in a composite structure;

Figure 2 is a schematic side view of an apparatus performing the metal section of figure 1;

Figure 3 is a detailed perspective view of a prestretching apparatus in the system of figure 2;

Figure 4 is a front elevation of the prestretching apparatus of figure 3;

Figure 5 is a side elevation of the prestretching apparatus of figure 3;

Figure 6 is a front elevation of a reaction station in the rollforming system of figure 1; and

Figure 7 is a front elevation of the fulcrum station of the system of figure 1.

Figure 8 is a side elevation of the action stage of the figure 1.

Figure 9 is a front elevation of the action stage of figure 1.

Figure 10 is a top elevation of the action stage of figure 1

Figure 11 is a front elevation of the action rollers of figures 8, 9 and 10.

Detailed description of the preferred embodiment

As shown in figure 1, a metal decking 10 is disclosed which is elongated and of generally C-section profile including a pan 12 and a pair of upstanding edge margins 14, 16 respectively. The metal decking member 10 in use is interconnected with a like member so as to form metal

decking. The metal decking is designed to have cast onto it a concrete slab which embeds the upstanding edge margins 14 and 16.

Each of the upstanding edge margins 14 and 16 include an inwardly directed portion 22, 24 which includes a respective lip return 26, 28 which is turned back towards or disposed generally parallel to its opposite edge margins.

The edge margins 14 and 16 also include respective longitudinally extending ribs 30 and 32. These longitudinal ribs are configured so that adjacent ribs of adjacent decking members interlock to prevent vertical and lateral separation of the metal decking members 10. This interlocking of the ribs eliminates the need for fasteners to secure adjacent decking members together. In the embodiment shown, the ribs interlock through their complimentary shape so that one of the ribs 30 resides within the other rib 32 of a decking member.

In addition, the pan 12 of the metal decking member 10 is longitudinally precambered about a bottom face 34 of the pan 12. The precamber of the web is about 0.6% measured as the maximum longitudinal offset of the pan 12 from a substantially flat plane and it is expressed as a percentage relative to the length of the member 12. In a typical arrangement, the decking member 10 is supplied in 6 metre lengths, and the maximum offset located in the middle of the member 10 is about 35 mm.

In use, concrete is cast on an upper face 36 of the pan 12. Under the load of the cast concrete, the member 10 is caused to at least partly deflect towards the flat plane under the significant weight of this concrete. The advantage of this longitudinal precamber is that it minimises the deflection from a flat line of the metal

decking once the concrete slab has been cast. As the maximum deflection is a criteria for determining the span lengths of the metal decking member 10, it allows the limit of the span length criteria to be extended. Another limiting factor on the span length is the strength at the interlock of the adjoining upstanding region between adjacent decking members. The use of the ribs 30 and 32 increases the strength at this interlock. As a result of the precamber and the increased strength at the interlock, the metal decking member 10 is able to span to about 5 metres unsupported as compared to spans of 3 metres for conventional decking member without a longitudinal precamber.

Figures 2 to 7 illustrate a roll former 50 to make the decking member 10 from sheet metal strip 100. The roll former 50 both shapes the section and incorporates the precamber.

The roll former 50 includes a series of 27 rollforming stages (generally designated 51) which shapes the decking member 10. These rollforming stages are not the subject of the invention and are therefore not illustrated in any detail. The roll former 50 includes an additional prestretching apparatus 52, and bending apparatus 53 which precamber the member 10 and which are disclosed in more detail below.

Turning firstly to the prestretching apparatus 53 which is best illustrated in Figures 3 to 5. The apparatus 53 is constructed as a single stage device 54 and is located upstream from the rollforming stages 51. The purpose of the device 53 is to differentially stretch the strip 100 so that it includes longitudinally extended portions 101, 102 which are more elongated than a mid section of the strip 103. The elongated portions 101, 102 are located adjacent the edge margins of the strip 100 in

the area where the strip is subjected to maximum bending during the rollforming stages 51. This device is designed to precondition the strip 100 so as to inhibit its tendency to bow about the upper face 36 of the metal decking member 10 which would otherwise occur during the rollforming stages 51. This tendency to bow upwardly is caused by a relative foreshortening of the edge margins caused in forming the upstanding edge margins 14, 16 of the member 10. It can also induce some precamber once any lateral shortening has been overcome.

The prestretching device uses rollers 55, 56, 57, 58 and 59 to differentially stretch the strip 100. These rollers are configured in a two over three arrangement and are designed so that they are disposed in the vicinity of the longitudinal edge margins of the strip 100. Further, each roller is tapered (as best illustrated in figure 4) so that the amount of stretching varies across each roller.

On exiting the prestretching device 54, the strip 100 is then fed into the rollforming stages 51. After passing through the rollforming stages 51, the shaped metal profile 10 is then introduced into the bending apparatus 53 which bends the member 10 about its lower face 34.

To bend the member 10, a three point bending process is used which requires that the bending apparatus 53 includes three separate stages; a reaction stage 60, a fulcrum stage 61, and an action stage 62. With this arrangement, the product is arranged to be bent around the fulcrum stage 61 whilst being supported in the reaction stage 60. The action stage is height adjustable so that it can be located below the line of the other stages of the roll former (51,52, 60 and 61) so as to introduce the bend into the member 10. The amount of bending is dependent on the amount the action stage 62 is offset from the line of

the other stages of the roll former 50.

Figure 6 illustrates the reaction stage 60 in more detail. In that stage the member 10 is well supported with the web 12 being captured between an infill roll 63 and floating block 64. The upper end 22, 24 of the upstanding margins 14 and 16 are in engagement with upper rollers 65 and 66. This arrangement enables the profile 10 to be well supported and in particular to resist any lifting of the web 12.

Figure 7 illustrates the fulcrum stage 61. During this stage, the member 10 is designed to introduce the precamber into the member 10. This is achieved by allowing the member 10 to bend about the infill roll 66. In addition the infill roll in the illustrated form incorporates a tapered surface which tapers from a mid point 68. This tapered roller introduces a lateral precamber across the web 12 as illustrated in figure 7. In the fulcrum stage 61, the upper edges 22 and 24 of the metal deck are not constrained as was the case in the reaction roller 60. This allows the necessary movement of the profile as it introduces the required precamber.

In alternate arrangements (not shown) the infill roll 66 incorporates a flat surface that maintains a flat profile across the web 12.

Figures 8 to 10 illustrate the action stage 62 comprising a height adjustable table 69 with a mounting plate 70 to which an action roll assembly 71 and shear frame assembly 72 both attach. The height adjustable table 69 provides adjustment via a plurality of jack screws 73 which control the extent of curvature of the member 10.

The shear frame assembly 72 houses a tilting shear assembly 74 comprises an actuated blade assembly located

at 78 and a reaction surface assembly 75. The perpendicularity in the cutting of the member 10 is maintained by the tilting shear assembly 74 pivoting on a bearing 76. The perpendicularity of the tilting shear assembly 74 is selected using angular adjustment bolts 77.

Fixed at the top of the tilting shear assembly 74 is a hydraulic cylinder (not shown) that actuates a moving blade 79. The reaction surface assembly 75 has two fixed shear blades 80 that remove a section (slug) of member 10 when the moving blade 79 is actuated, wherein the removed section is ejected via a chute 81.

Figure 11 illustrates the action roll assembly 71. A pair of action rolls 82 guide the member 10 into the shear opening in the shear frame assembly 72. The action roll assembly 71 compensates for changes in the height of the adjustable table 69. Adjustment of the action rolls 82 is provided in the action roll assembly by an arrangement of adjustment bolts 83.

Accordingly, the rollforming apparatus 50 provides a system where the metal strip can be profiled and precambered in a single operation. Furthermore the additional functionality of the roll former 50 to enable the precamber can be easily introduced into an existing rollforming line merely by including additional stages. Furthermore by preconditioning the metal strip through differential prestretching, the amount the metal section can be bent at the bending stage is increased without the risk of buckling of the section or introducing significant areas of weakness. With this arrangement, it is possible to introduce longitudinal precambers in the order of 6% as advantageously used in the decking member 10.

Variations and modifications may be made to the parts previously described without departing from the spirit or

ambit of the present invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of roll forming a metal section from sheet metal strip comprising of the steps of;
- differentially stretching the metal strip in its longitudinal direction so that at least one portion of the metal strip is more elongated than a laterally adjacent portion of the strip;
- roll forming the differentially stretched metal strip to form a profiled section; and
- bending the profiled section so as to introduce a longitudinal precamber in the profiled section.

2. A method according to claim 1, wherein the elongated portion(s) extend continuously in a longitudinal direction of the metal strip.

3. A method according to claim 1 or claim 2, wherein the elongated portions(s) are aligned in areas of the metal strip which require stretching to provide the required precamberin the profiled section.

4. A method according to any preceeding claim, wherein the profiled section is of a generally C-shape having a pan section and upturned edges which extend from one face of the strip, and wherein the profiled section is bent about the face opposite to that in which the upturned edges of the profiled section extend.

5. A method according to any preceeding claim, wherein the metal strip is roll formed so as to be differentially stretched.

6. A method according to any preceeding claim, wherein the profiled section is caused to bend about a fulcrum to introduce the longitudinal precamber.

7. A method according to claim 6, wherein the profiled section is restrained upstream of the fulcrum, and is caused to be deflected from the line of the roll formers downstream of the fulcrum.

8. A method according to claim 7, wherein the profiled section is cut into discrete lengths downstream of the fulcrum,a shearing assembly which also causes the profiled section to be deflected from the line of the roll formers.

9. An apparatus for forming a metal section from sheet metal strip, the apparatus comprising;

stretching apparatus which is operative to differentially stretch the metal strip in its longitudinal direction so that at least one portion of the metal strip is more elongated than a laterally adjacent portion of the strip;

roll forming apparatus operative to roll form the differentially stretched strip to form a profiled section; and

bending apparatus operative to bend the profiled section so as to introduce a longitudinal precamber in the profiled section.

10. A forming apparatus according to claim 9, wherein the stretching apparatus includes at least one roll which is operative to engage a portion of the metal strip so as to elongate the engaged portion of the strip.

11. A forming apparatus according to claim 10, wherein the roll has a tapered surface so as to vary the amount of stretching across said engaged portion of the metal strip.

12. A forming apparatus according to any one of claims 9 to 11, wherein the bending apparatus comprises a multiple stage device which is operative to introduce a three point bend to said profiled section.

13. A forming apparatus according to claim 12, wherein the bending apparatus includes a reaction stage operative to restrain the metal profile, a fulcrum stage about which the profiled section bends, and an action stage which is operative to induce a load on said profiled section so as to deflect the profiled section from the line of said roll formers.

14. A forming apparatus according to claim 13, wherein the action stage is incorporated as part of the shearing assembly which is operative to cut said profiled section in discrete lengths.

15. A forming apparatus according to claim 14, wherein the shearing assembly comprises an assembly frame, a shearing block attached to the frame and operative to receive the profiled metal section, and a cutting element which is moveable relative to the shearing block, wherein the shearing assembly is height adjustable so that the relative height of the shearing block can be adjusted so as to cause said profiled section to be deflected from the line of the roll formers.

16. A forming apparatus according to claim 15, wherein the angle of the cutting element to the frame can be adjusted.

17. A shearing assembly for use in cutting a profiled metal section into discrete lengths, the shearing assembly comprising an assembly frame, a shearing block attached to the frame and operative to receive the profiled metal section, and a cutting element which is moveable relative to the shearing block, wherein the shearing assembly is height adjustable so that the relative height of the shearing block can be adjusted, and wherein the angle of the cutting element relative to the frame can be adjusted.

18. A shearing assembly according to claim 17, wherein the cutting element is pivotally mounted to the shearing block.

Dated this 15th day of April 2003
BHP STEEL LIMITED
By their Patent Attorneys
GRIFFITH HACK

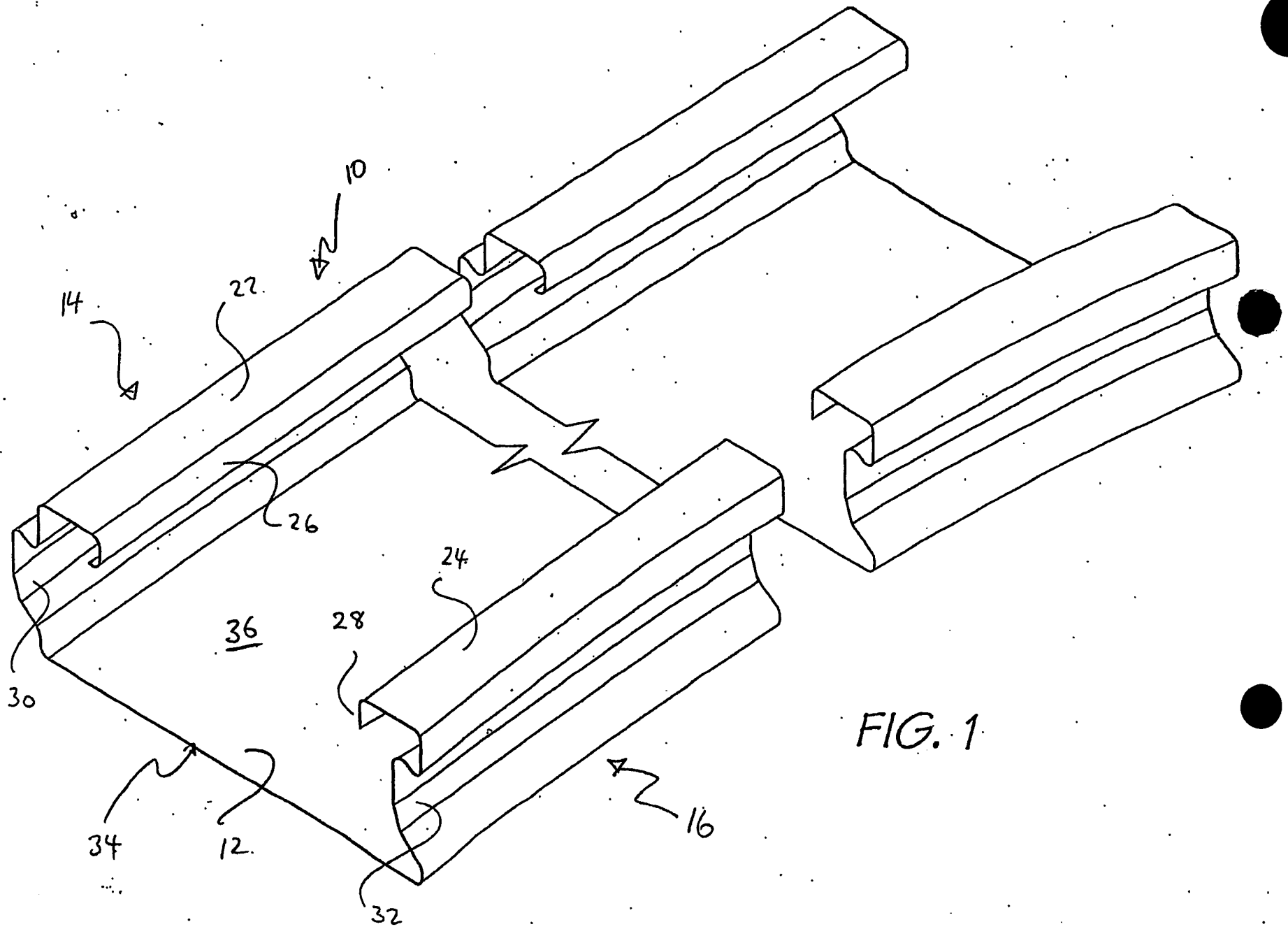


FIG. 1

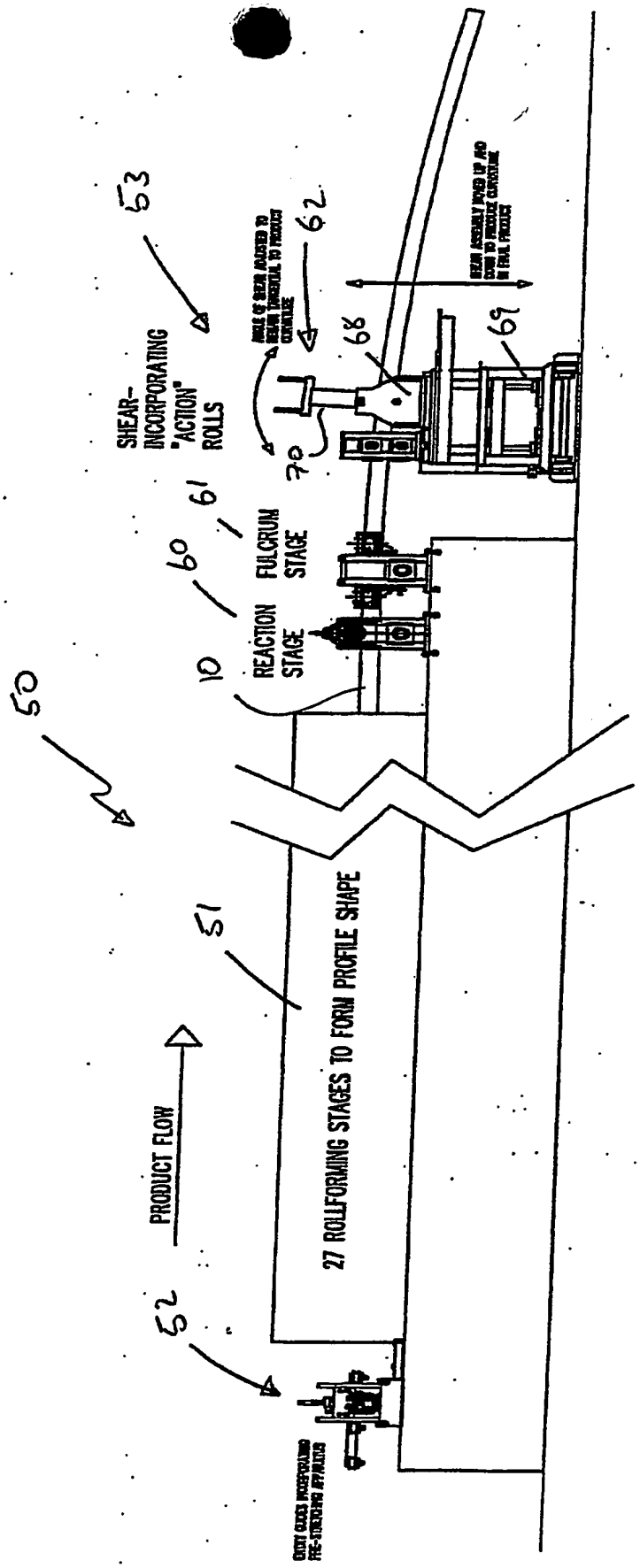


FIG. 2

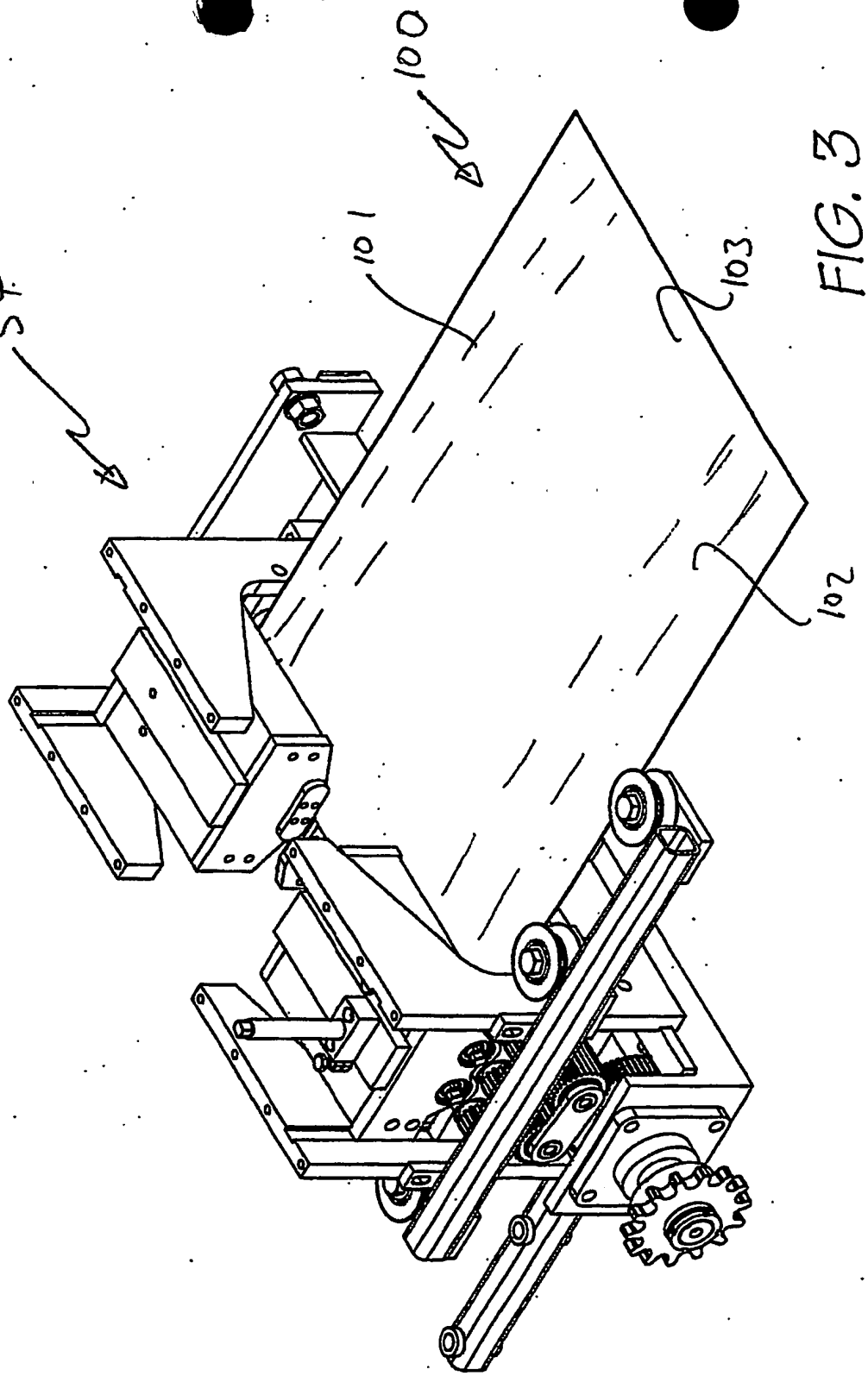


FIG. 3

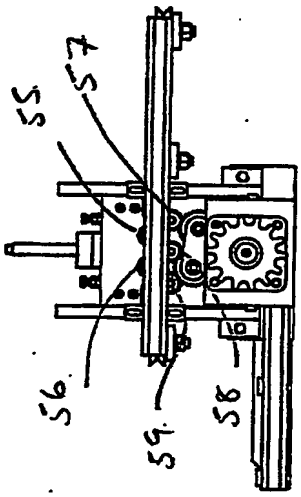
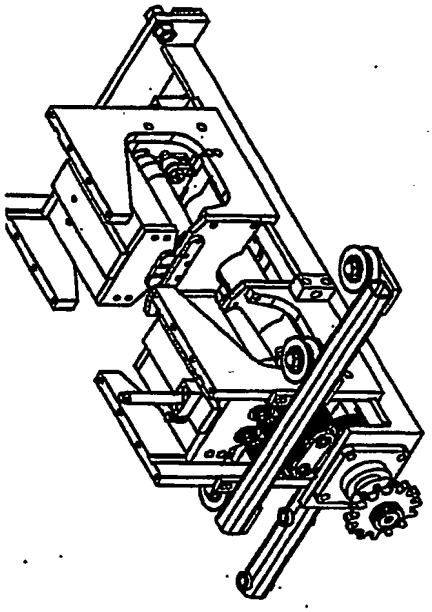


FIG. 5



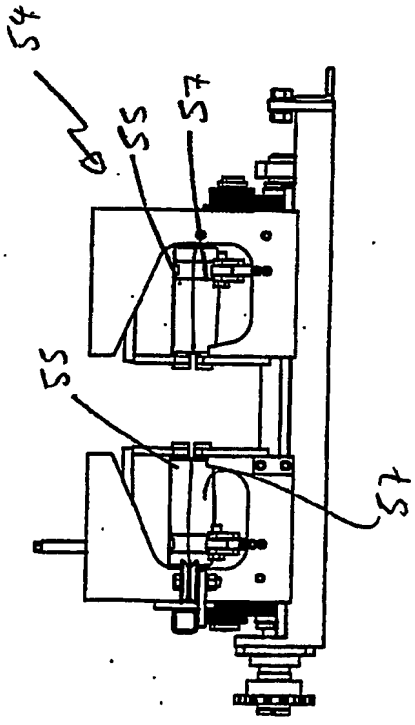
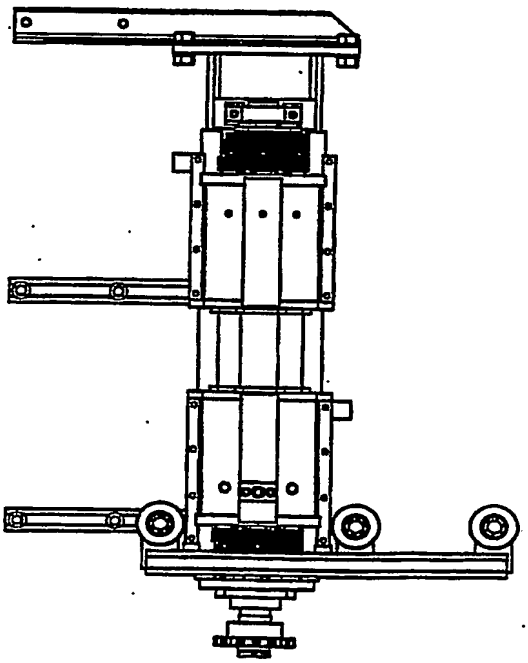


FIG. 4



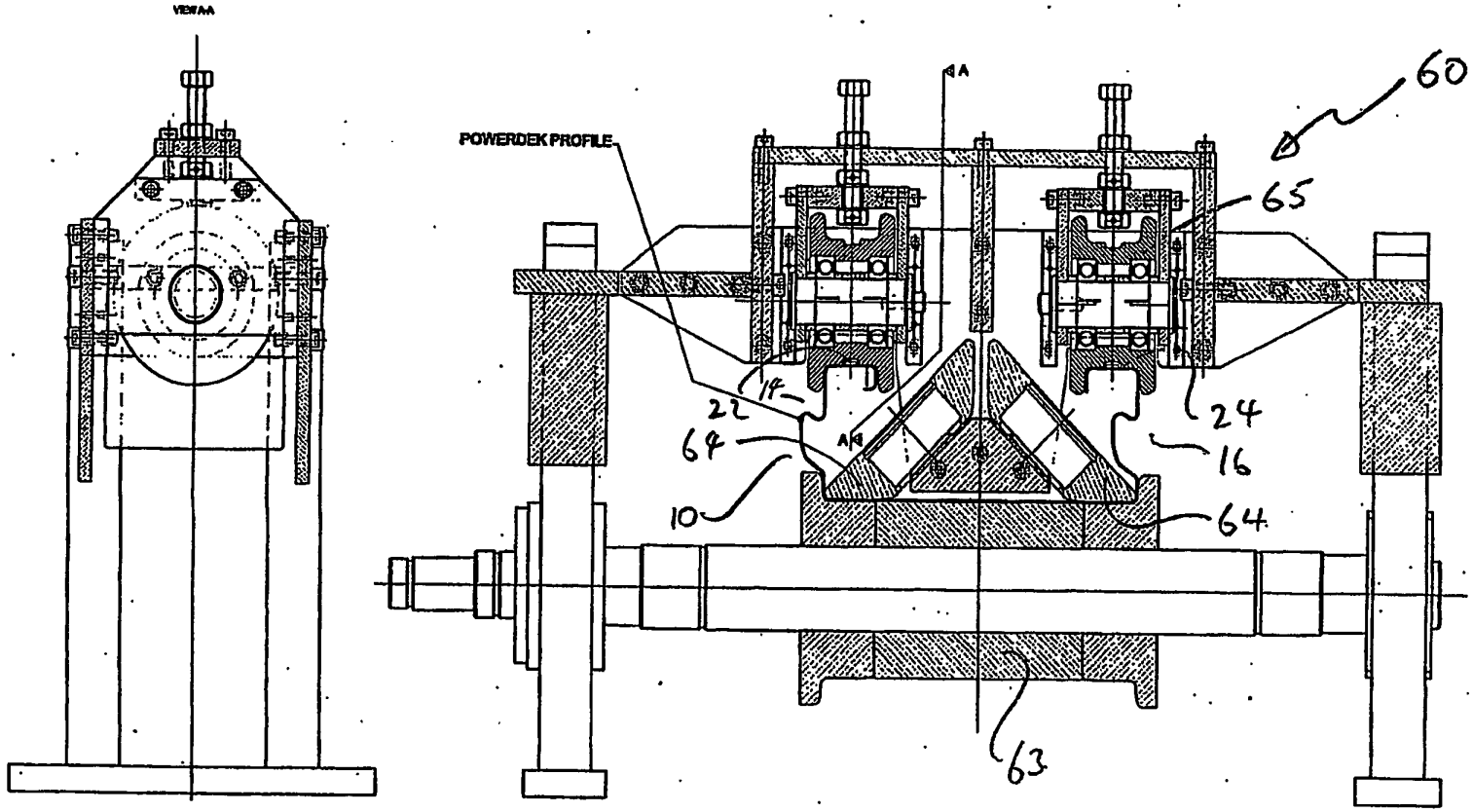


FIG. 6

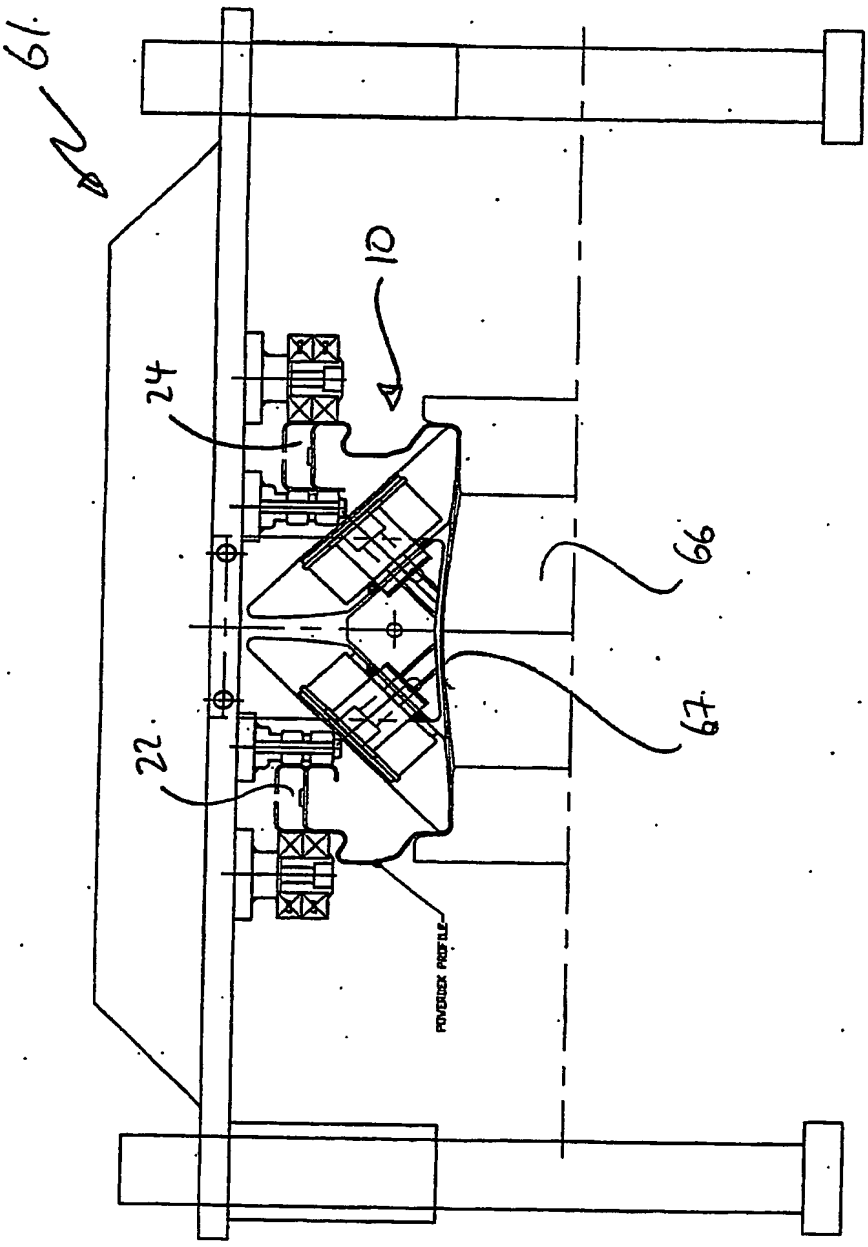


FIG. 7

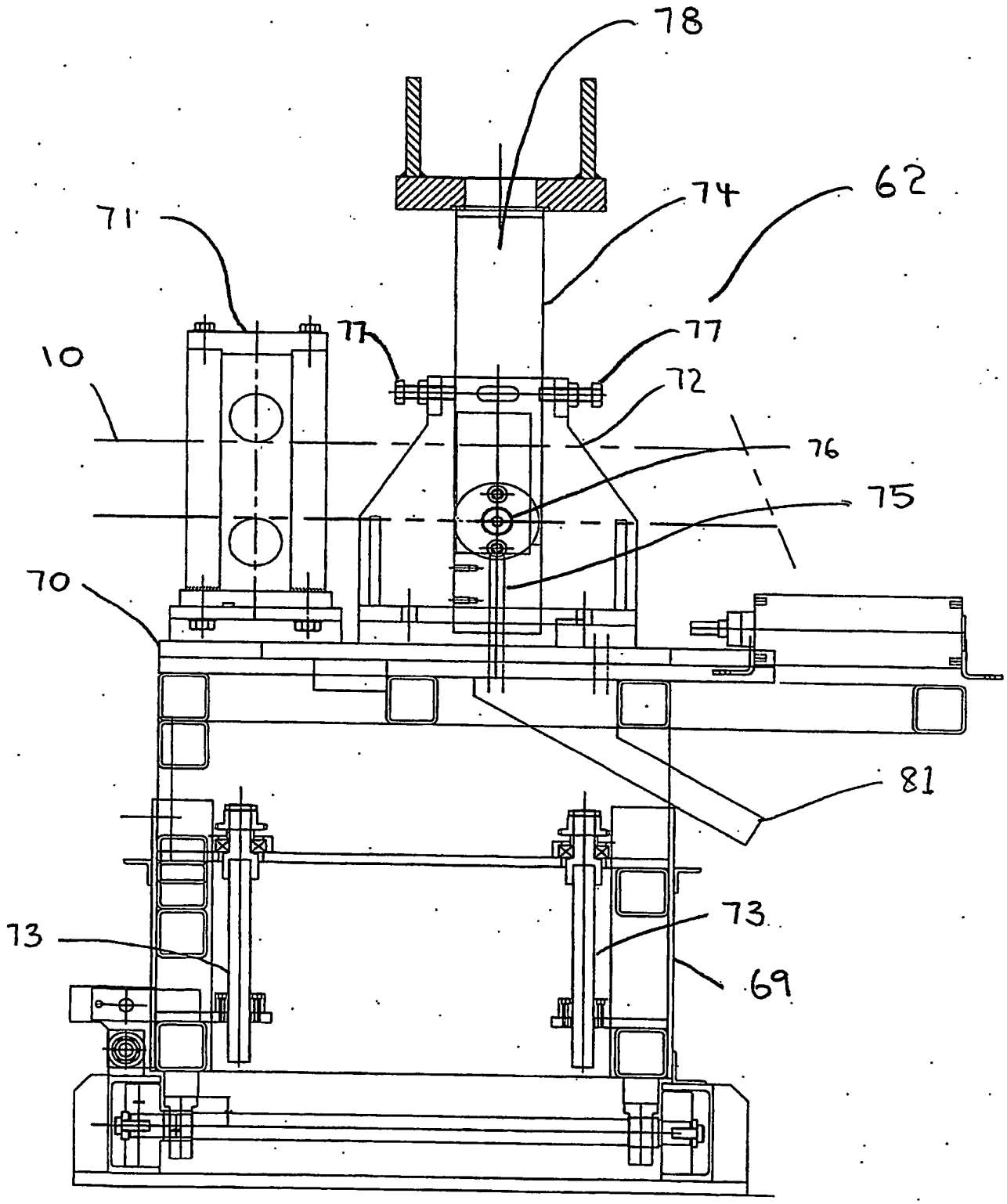


FIG. 8

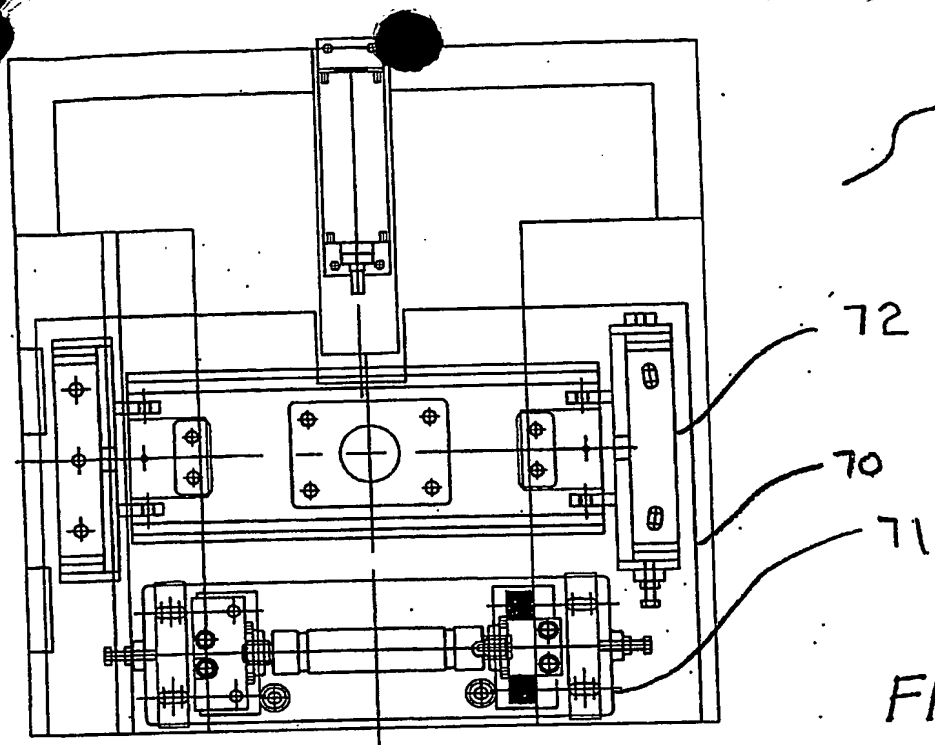


FIG. 10

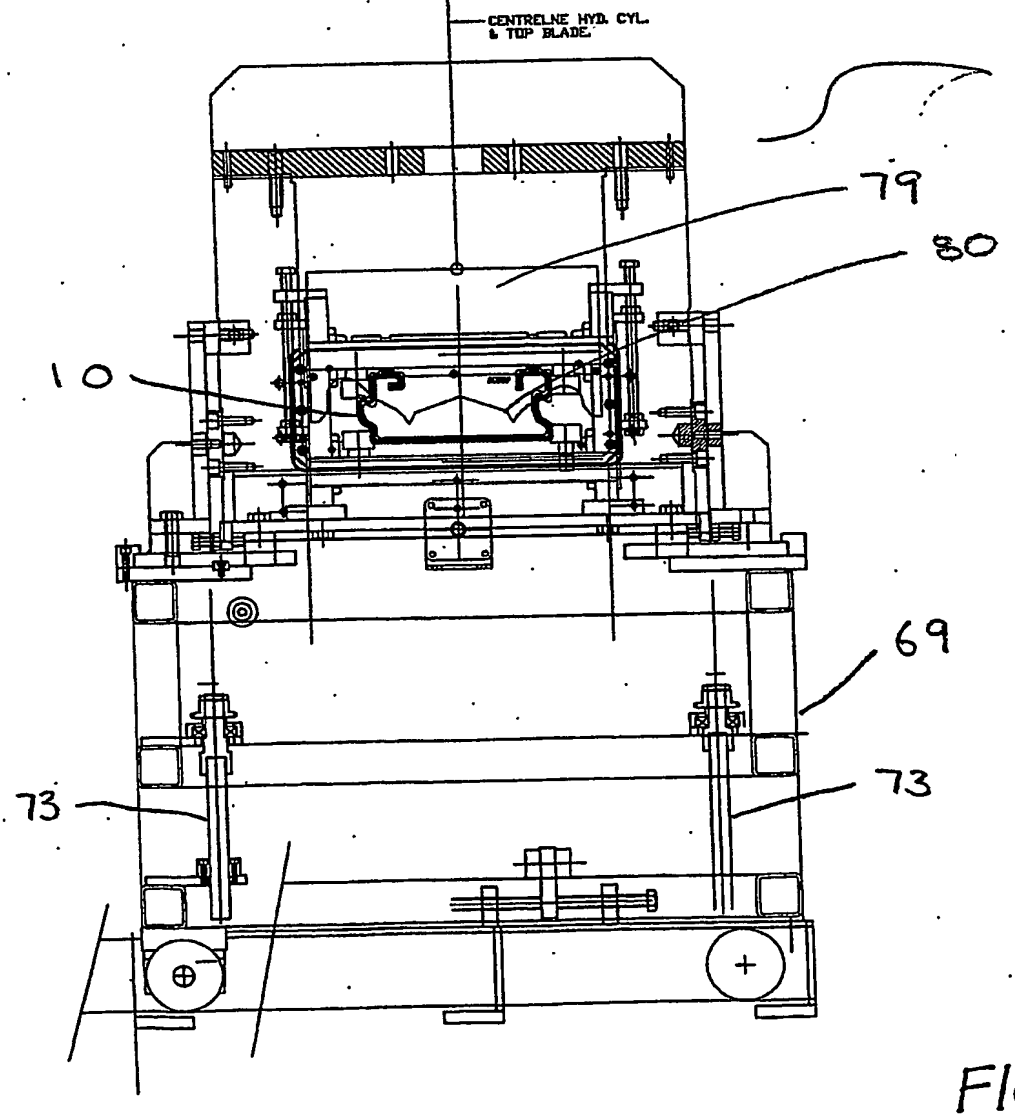


FIG. 9

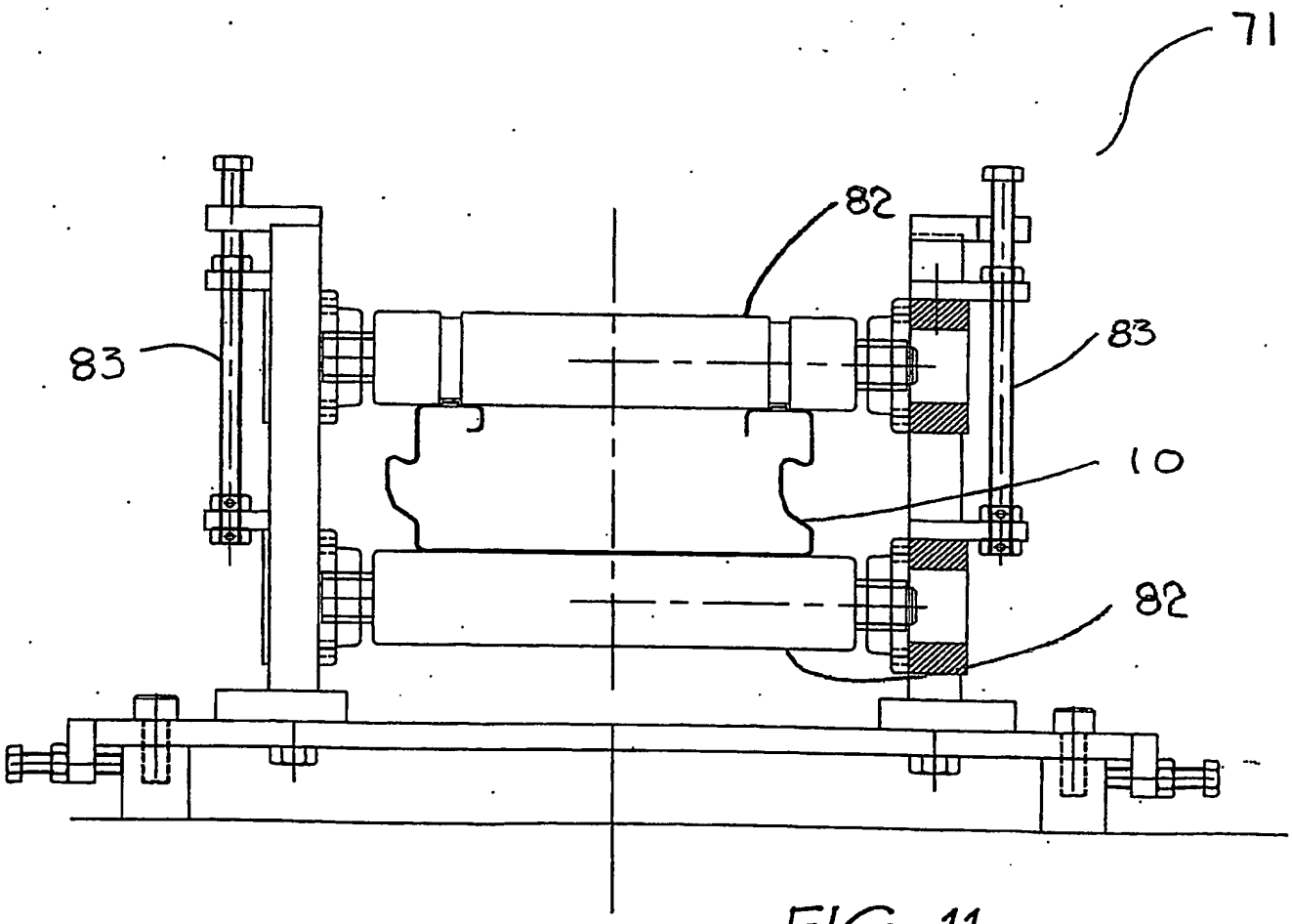


FIG. 11